

REMARKS

Claims 1 and 26 have been amended. Upon entry of this amendment, claims 1-42 will be pending in the application.

* In response to the objection to Fig. 1 raised in the Office action, a Letter to the Official Draftsman submitting a corrected drawing is enclosed. Fig. 1 has been corrected to eliminate the duplicate use of reference character 39 in connection with both the recycle conduit feeding into gas mixer 23 and the incinerator. In the corrected drawing, the incinerator is now designated by reference character 40. The specification has also been amended to reflect the correction of Fig. 1.

Claims 1 and 26 have been amended in accordance with the Examiner's recommendations on page 3 of the Office action. However, applicants have not amended claim 13 as suggested by the Examiner. Applicants respectfully point out that the term "offgas" in claim 13 is qualified by the phrase "from petroleum refining, gas liquefaction or rubber vulcanization operations." Accordingly, the Examiner's proposed amendment is inconsistent with the proper syntax of this claim.

* Attached hereto is a marked-up version of the changes made to the specification and the claims by the current amendment. The attached pages are captioned **"Version With Markings to Show Changes Made"**.

Applicants acknowledge the Examiner's allowance of dependent claims 26-30 and claims 33-42.

Reconsideration is respectfully requested of the rejection of claims 1-25, 31 and 32 under 35 U.S.C. §103(a). These claims are submitted as patentable over the Gas Purification text by Kohl et al. and U.S. Patent No. 5,851,265 (Burmester et al).

Claim 1 is directed to a process for the production of sulfur from an acid feed gas stream containing hydrogen sulfide. In the process of claim 1, a feed gas mixture comprising hydrogen

sulfide and sulfur dioxide is contacted with a Claus conversion catalyst in a single Claus catalytic reaction zone to form a product gas effluent comprising elemental sulfur and water. The product gas effluent is cooled to condense and separate elemental sulfur from the product gas effluent and form a tail gas effluent. **A portion of the tail gas effluent** is sent to an incinerator and combusted with a source of oxygen to form a combustion gas effluent comprising sulfur dioxide. The combustion gas effluent is then subjected to a sulfur dioxide absorption/stripping cycle to produce a sulfur dioxide-enriched stripper gas. The sulfur dioxide-enriched stripper gas is then combined with at least a portion of the acid gas feed stream in the feed gas mixture introduced into the Claus catalytic reaction zone. In accordance with the process defined in claim 1, the temperature within the Claus catalytic reaction zone is moderated by including **the remainder of the tail gas effluent** in the feed gas mixture introduced into the Claus catalytic reaction zone. By proportioning the split of tail gas effluent between the incinerator and the Claus catalytic reaction zone, the temperature within the Claus catalytic reaction zone can be moderated as desired.

Gas Purification has been cited as disclosing a Claus process plant for converting hydrogen sulfide to sulfur which includes passing a hydrogen sulfide and sulfur dioxide-containing gas stream through a catalytic stage, passing the sulfur-containing gas which exits the catalytic stage through a condenser to form a tail gas which is then passed through an incinerator to produce an off-gas containing sulfur dioxide.

Burmester et al. has been cited for disclosing contacting the incinerator off-gas from a Claus plant with a liquid sulfur dioxide absorbent in an absorption zone to produce a sulfur dioxide-rich solvent, stripping sulfur dioxide from the rich

solvent to produce a sulfur dioxide-enriched stripper gas stream and feeding the sulfur dioxide-enriched stripper gas to the Claus plant.

In order to establish a *prima facie* case of obviousness, the prior art references must teach or suggest all of the claim limitations. Applicants respectfully submit that the references relied on in the Office action fail to establish a *prima facie* case of obviousness with respect to the process defined in claim 1.

On page 7 of the Office action, the Examiner contends that "the effect that the recycled sulfur dioxide-containing stripper gas has on the temperature in the catalytic reactor is noted, but such description of the advantage of doing what is obvious from the prior art is *prima facie* obvious" (emphasis added). Based on this statement, it is apparent that the Examiner has either overlooked or misconstrued the requirement of claim 1 of recycling a portion of the tail gas effluent exiting the sulfur condenser and introducing it into the Claus catalytic reaction zone as part of the feed gas mixture as a means of moderating the temperature in the catalyst zone. The sulfur dioxide-containing stripper gas referred to by the Examiner in the above-quoted statement is identified by reference character 19 in Fig. 1 of the application and is not the tail gas effluent exiting the sulfur condenser recited in claim 1. The portion of the condenser tail gas stream introduced into the Claus catalytic reaction zone as part of the feed gas mixture in accordance with the process of claim 1 is represented by reference character 39 in Fig. 1 of the application. Neither Gas Purification or Burmaster et al. disclose or suggest recycling a portion of the tail gas effluent exiting the condenser to the Claus catalytic reaction zone as a means of temperature control or, for that matter, any other purpose. Moreover, the tail gas effluent

exiting the sulfur condenser typically contains water vapor, trace amounts of sulfur, unreacted sulfur dioxide and hydrogen sulfide as well as other components of the incoming acid gas such as carbon dioxide and hydrocarbons. This is in stark contrast to the composition of the sulfur dioxide-containing stripper gas, which, according to the present invention, preferably contains at least about 80 mole percent sulfur dioxide. In view of these considerable compositional differences, the teaching in Burmaster et al. of recycling the sulfur dioxide-enriched stripper gas to a Claus plant does not in any way suggest recycling a portion of the tail gas effluent from the sulfur condenser to the Claus catalytic zone as required by claim 1.

In the absence of any teaching or suggestion of the affirmative limitation of claim 1 requiring that a portion of the tail gas effluent from the sulfur condenser be introduced into the Claus catalytic reaction zone as part of the feed gas mixture, applicants respectfully submit that the references upon which the Examiner relies fail to establish a *prima facie* case of obviousness. Accordingly, claim 1 is submitted as patentable over Gas Purification in view of Burmaster, et al. Claims 2-25, 31 and 32, which depend from claim 1, are likewise submitted as patentable over these references for the reasons stated with respect to claim 1.

Further grounds of nonobviousness can be cited in support of the claims 1-25, 31 and 32 and applicants reserve the right to present such further grounds of patentability based on one or more of the features recited in these claims. However, in view of the strong basis for patentability of claim 1 as already expressed above, it is respectfully submitted that this record need not be further extended by discussion of other novel and advantageous combinations that are defined by the pending claims.

Conclusion

In view of the foregoing, applicants respectfully request allowance of all pending claims.

Applicants do not believe any fees are due in connection with this amendment. However, the Commissioner is authorized to charge any fee deficiency in connection with this amendment to Deposit Account No. 19-1345.

Respectfully submitted,



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*Attachment/Enclosure

Express Mail No. EL946585042US

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

The paragraph beginning at page 20, line 12 has been amended as follows:

The portion of tail gas effluent 37 forwarded to tail gas treatment contains water vapor, trace amounts of sulfur, unreacted sulfur dioxide and hydrogen sulfide as well as other components of the incoming acid gas such as carbon dioxide and hydrocarbons. This gas is introduced into a combustion zone of an incinerator [39] 40 along with an excess of combustion air 41 or other source of oxygen and supplemental fuel gas 43 as needed. In the combustion zone, sulfur species present in the tail gas effluent are oxidized to sulfur dioxide and any hydrocarbons present are oxidized to carbon dioxide and water in the excess air environment to form a combustion gas effluent 45 comprising sulfur dioxide. To moderate temperature, quenching water can be introduced into the incinerator. Alternatively, if the acid gas is pretreated to remove unsaturated hydrocarbons using an aqueous sulfuric acid wash as described above, the organic sulfate waste stream 13 can be fed into incinerator [39] 40 to cool the incinerator by both evaporation of water and thermal decomposition of the sulfate waste into sulfur dioxide, oxygen and water. Other waste streams from the installation may also be fed to incinerator [39] 40 and used for their combustible content including sour water stripper off-gas derived from petroleum cracking operations. This avoids problems associated with sending sour water stripper off-gas through the sulfur recovery unit such as plugging of heat exchanger equipment, catalyst fouling and corrosion of

process equipment. Typically, this is a very troublesome stream to process in Claus installations since it contains ammonia in addition to hydrogen sulfide. Complete destruction of ammonia is required in a conventional Claus plant, since ammonia can form salts leading to plugging and corrosion of downstream process equipment. For complete destruction of ammonia and minimal formation of nitrogen oxides (NO_x), high temperatures (e.g., in excess of 1200° C) and reducing conditions are needed. Combustion air 41 may be supplied under pressure to incinerator [39] 40 in two zones, one which is operated under reducing conditions and the following zone operated under oxidizing conditions.

The paragraph beginning at page 21, line 24 has been amended as follows:

Leaving incinerator [39] 40, hot combustion gas effluent 45 is cooled in an indirect heat exchanger 47. Depending upon the size of the installation, heat exchanger 47 may take the form of a waste heat boiler or recuperator. Cooled combustion gas 49 is then delivered to a system for the selective removal and recovery of sulfur dioxide such as that described in U.S. Patent No. 5,851,265 (Burmaster et al.), the entire disclosure of which is incorporated herein by reference. In such a system, the combustion gas effluent is introduced into a sulfur dioxide absorption zone and contacted with a liquid absorbent for selective absorption of sulfur dioxide to transfer sulfur dioxide from the combustion gas to the absorbent and produce an exhaust gas from which sulfur dioxide has been substantially removed and a sulfur dioxide-rich absorbent. Sulfur dioxide is stripped from the rich absorbent in a sulfur dioxide stripping zone to produce a lean absorbent and a sulfur dioxide-enriched

stripper gas. The regenerated lean absorbent is recycled to the absorption zone for further selective absorption of sulfur dioxide from the combustion gas effluent. The system disclosed by Burmaster et al. is preferred in the practice of the present invention and for purposes of the following description, particular reference is made to the portion of that disclosure at col. 4, line 5 to col. 9, line 52 with any modifications or specific preferred features set forth below. However, it should be understood that various sulfur dioxide absorbents and sulfur dioxide recovery process schemes may be employed in the practice of the present invention.

The paragraph beginning at page 30, line 17 has been amended as follows:

As shown in Fig. 1, the sulfur dioxide concentration in the Claus catalytic reaction zone may be increased by a bypass line 95 which bypasses at least a portion of the incoming acid gas feed stream 1 around catalytic converter 27 and introduces it directly into incinerator [39] 40. Hydrogen sulfide in the acid gas is oxidized to sulfur dioxide in the incinerator and fed back to the Claus catalytic reaction zone as part of sulfur dioxide-enriched stripper gas 19.

The paragraph beginning at page 36, line 6 has been amended as follows:

The product gas effluent exiting the converter was cooled in sulfur condenser 31 to condense and separate sulfur 33 and produce low pressure steam. A mesh pad within the sulfur condenser ensured minimal sulfur entrainment in the tail gas effluent 35 exiting the condenser. The portion

of the tail gas effluent 37 not recycled to the converter was introduced into tail gas incinerator [39] 40 along with combustion air 41 and sour water stripper gas containing ammonia, water vapor and hydrogen sulfide. Sulfur species present in the gases fed to the incinerator were oxidized to sulfur dioxide and a minor amount to sulfur trioxide. With the combustible content of the tail gas effluent augmented by the sour water stripper gas, there was no need for supplemental fuel gas in the incinerator.

IN THE CLAIMS:

Claim 1 has been amended as follows:

1. **(once amended)** A process for the production of elemental sulfur from an acid gas feed stream containing hydrogen sulfide, the process comprising the steps of:

contacting a feed gas mixture comprising at least a portion of the acid gas feed stream and sulfur dioxide with a Claus conversion catalyst in a single Claus catalytic reaction zone at a temperature effective for the reaction between hydrogen sulfide and sulfur dioxide to form a product gas effluent comprising elemental sulfur and water;

cooling the product gas effluent to condense and separate elemental sulfur from the product gas effluent and form a tail gas effluent;

combusting a portion of the tail gas effluent with a source of oxygen in a combustion zone to oxidize sulfur species present in the tail gas effluent and form a combustion gas effluent comprising sulfur dioxide;

contacting the combustion gas effluent with a liquid absorbent for sulfur dioxide in a sulfur dioxide absorption zone to selectively transfer sulfur dioxide from the combustion gas effluent to the absorbent and produce an exhaust gas from which sulfur dioxide has been substantially removed and a sulfur dioxide-rich absorbent;

stripping sulfur dioxide from the rich absorbent in a sulfur dioxide stripping zone to produce a lean **[absbent]** **absorbent** and a sulfur dioxide-enriched stripper gas;

recycling the lean absorbent to the sulfur dioxide absorption zone for further selective absorption of sulfur dioxide from the combustion gas effluent; and

mixing the sulfur dioxide-enriched stripper gas with at least a portion of the acid gas feed stream and the remainder of the tail gas effluent to form the feed gas mixture introduced into the Claus catalytic reaction zone, the proportion of the tail gas effluent introduced into the Claus catalytic reaction zone as part of the feed gas mixture being sufficient to moderate the temperature within the Claus catalytic reaction zone.

Claim 26 has been amended as follows:

26. **(once amended)** The process as set forth in claim 1 wherein the acid gas feed stream further comprises an unsaturated hydrocarbon component selected from the group consisting of linear olefins, **[and]** branched olefins, aromatic hydrocarbons and mixtures thereof, the process further comprising pretreating the acid gas feed stream upstream of the Claus catalytic reaction zone to reduce the concentration of the unsaturated hydrocarbon component and inhibit deactivation of the Claus conversion catalyst, pretreatment of the acid gas feed stream comprising:

contacting at least a portion of the acid gas feed stream with an aqueous acid wash to react unsaturated hydrocarbons with the acid and form an addition reaction product; and

separating the addition reaction product from the acid gas feed stream.